

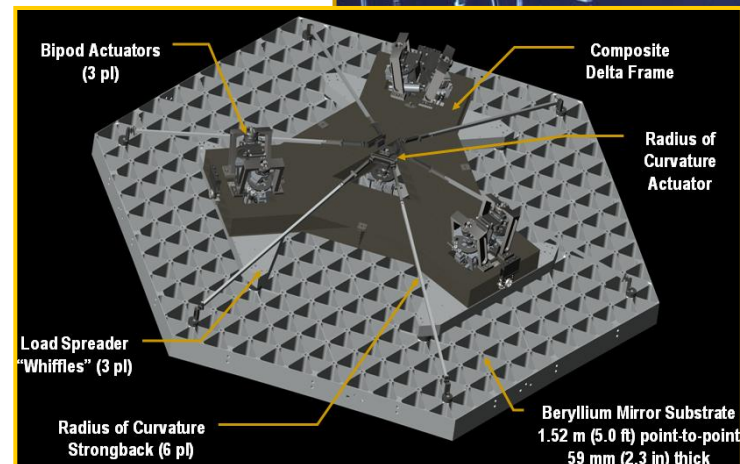
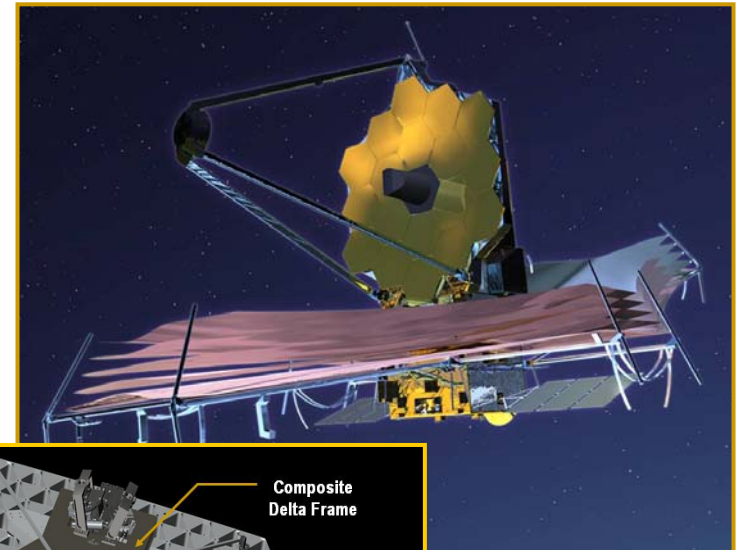


JWST Mirror Manufacturing Overview



- Ball Aerospace
 - Primary Mirror Assembly System design
 - Primary Support and Actuation System (PSAS) Design and Analysis
 - System Integration and Test
- Brush Wellman
 - Powder production processing
 - Blank HIPing and clean up machining
- Axsys Technologies
 - Facilitization for mirror production
 - Finish machining, light weighting and initial aspherization
- Tinsley Labs
 - Facilitization for mirror production
 - Optical polishing
- MSFC
 - Cryogenic optical testing

- Mirror Characteristics
 - O-30H spherical powder beryllium
 - Hexagon shaped 1.52 meters across
 - Light weighted
 - Polished to ~ 20 nm-rms at < 50 Kelvin





Brush Wellman Status – All Blanks Finished!



NORTHROP GRUMMAN
Space Technology

ITT Industries
Engineered for life



ATK
AERIAL TECHNOLOGY

Powder production

Loading and Degassing

HIP Preparation

Post HIP

Last Eight JWST Blanks Ready For Shipment

Etching and stress relieve

Clean up Machining

Sawing in Half

Finish Machining

Final Inspection

Shipment



Facilitization complete at Axsys Technologies to manufacture all JWST beryllium machined blanks



- **Dedicated Building on UPS backup**
- **8 CNC Milling Machines**
- **2 Coordinate Measuring Machines**
- **Heat Treat Chamber**
- **Acid Etching Station**
- **Inspection and Mirror Prep Areas**



5 of 8 Machining Centers, 1 CMM and other production preparation equipment installed in Axsys JWST building



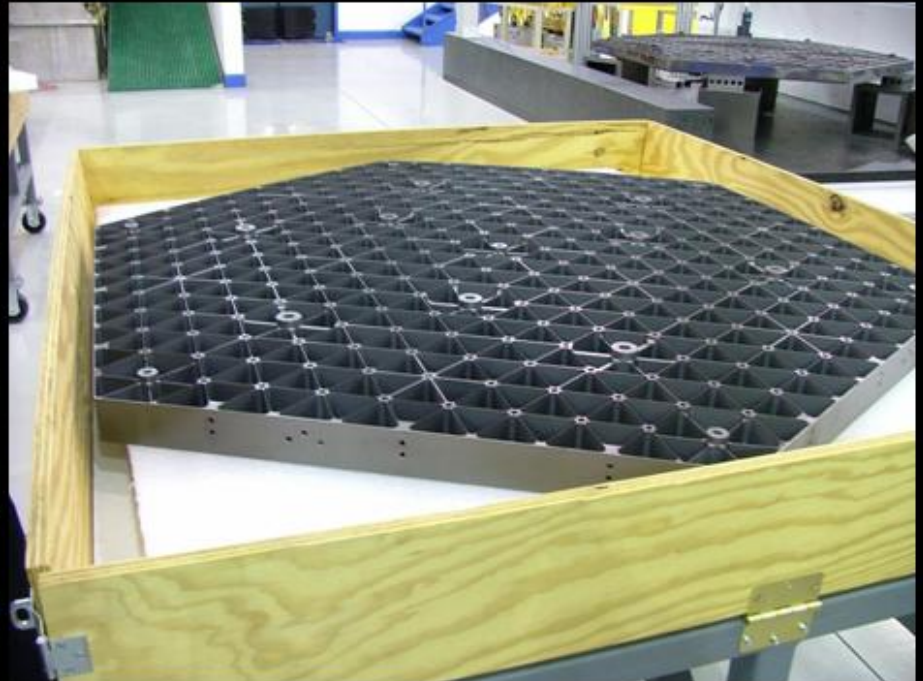
EDU Mirror Ready for Final Inspection – Axsys Technologies



PMSA EDU (EDU-B, A0) PM Segment



PMSA EDU on CMM during front surface optical inspection



PMSA EDU on handling cart showing rear side machined ribs



First two flight batches in process – Axsys Technologies



Batch #1 (Pathfinder) PM Segments



PMSA #1 (EDU-A / A1)



PMSA #2 (3 / B1)



PMSA #3 (4 / C1)

Batch #2 PM Segments



PMSA #4 (5 / A2)



PMSA #5 (6 / B2)



PMSA #6 (7 / C2)



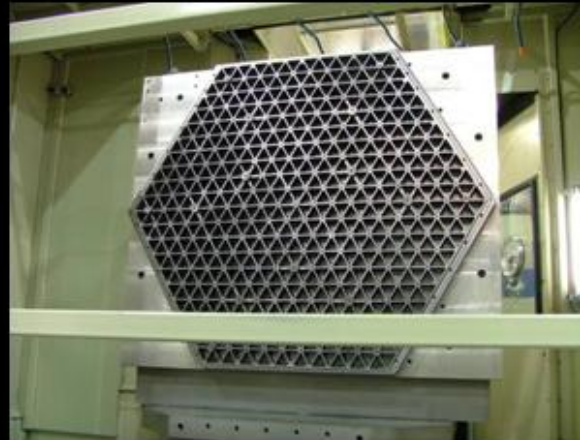
Second two flight batches in process – Axsys Technologies



Batch #3 PM Segments



PMSA #7 (13 / A4)



PMSA #8 (11 / B3)



PMSA #9 (12 / C3)

Batch #4 PM Segments



PMSA #10 (16 / A5)



PMSA #11 (14 / B4)



PMSA #12 (15 / C4)



Beryllium Subcontract Accomplishments Last Month – Axsys Technologies



Batch #5 PM Segments



PMSA #13 (8 / A3)

*Received at Axsys
but not released to production*

PMSA #14 (17 / B5)

*Received at Axsys
but not released to production*

PMSA #15 (18 / C5)

Batch #6 PM Segments

*Production complete at BWI
but not shipped to Axsys yet*

PMSA #16

*Production complete at BWI
but not shipped to Axsys yet*

PMSA #17

*Production complete at BWI
but not shipped to Axsys yet*

PMSA #18



Facilitization and Production Preparation Progressing at Tinsley



- **Dedicated facility**
- **8 CCOS Centers**
- **2 Coordinate Measuring Machines**
- **2 Horizontal Optical Test Stations**
- **IR surface metrology**
- **Thermal and Cryogenic Chambers**
- **Handling and transportation fixtures**
- **Inspection and Mirror Prep Areas**





Custom Handling and Processing Fixtures – Tinsley Laboratories



NORTHROP GRUMMAN
Space Technology



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Engineered for life



Segment Transfer Station



Segment Transfer Cart



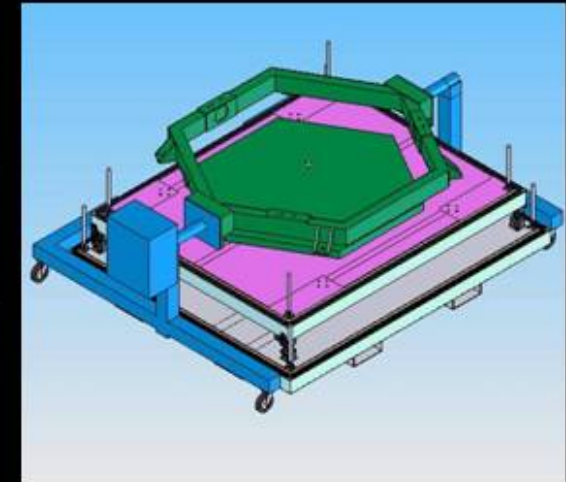
Cart and Transfer Station



Cryo-Rate Transfer Carriage



Thermal/Cryo Chamber



Flipping Cart



CCOS Machine Loading Tooling – Tinsley Laboratories



CCOS
Machine
Mount

Bridge

Surrogate
Segment

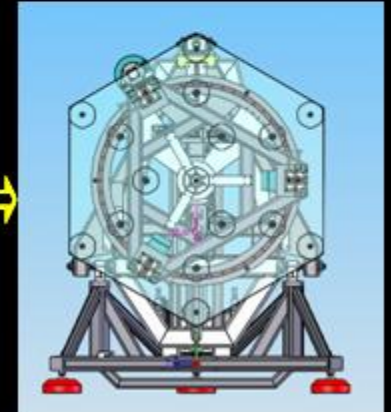
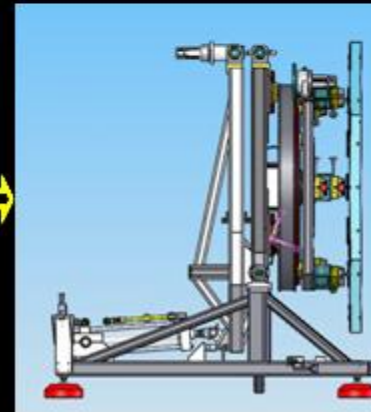
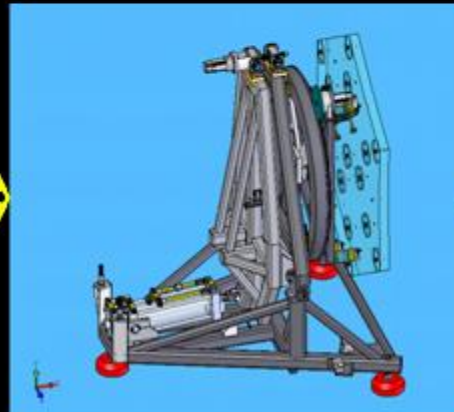
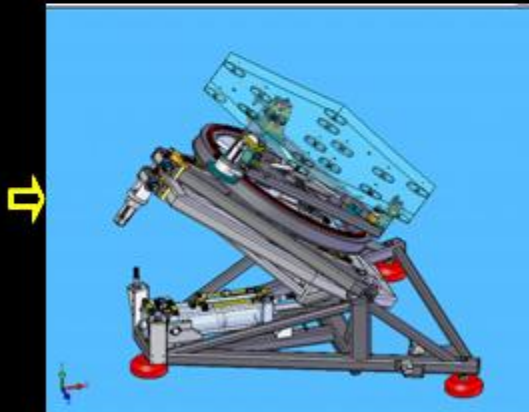
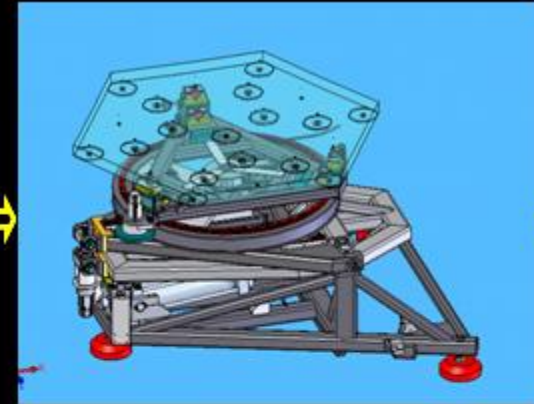
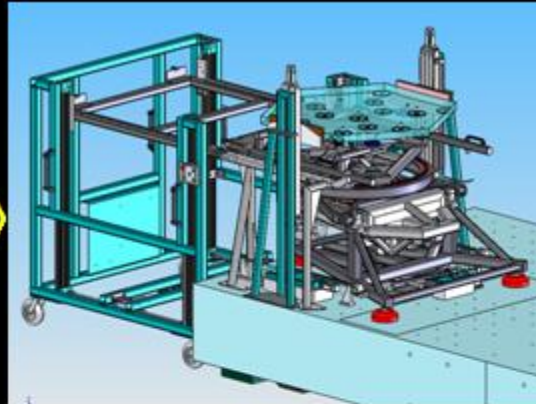
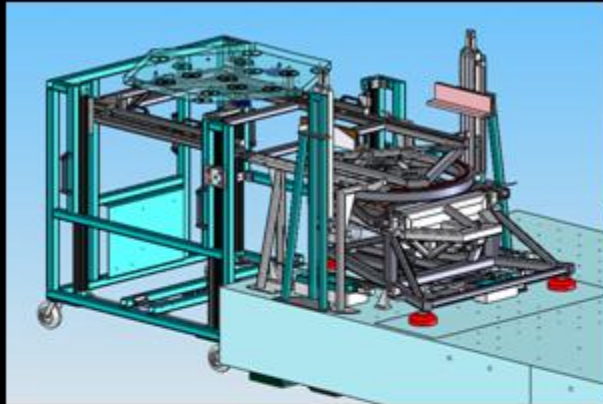
Station
Transfer
Carriage

Transport
Cart



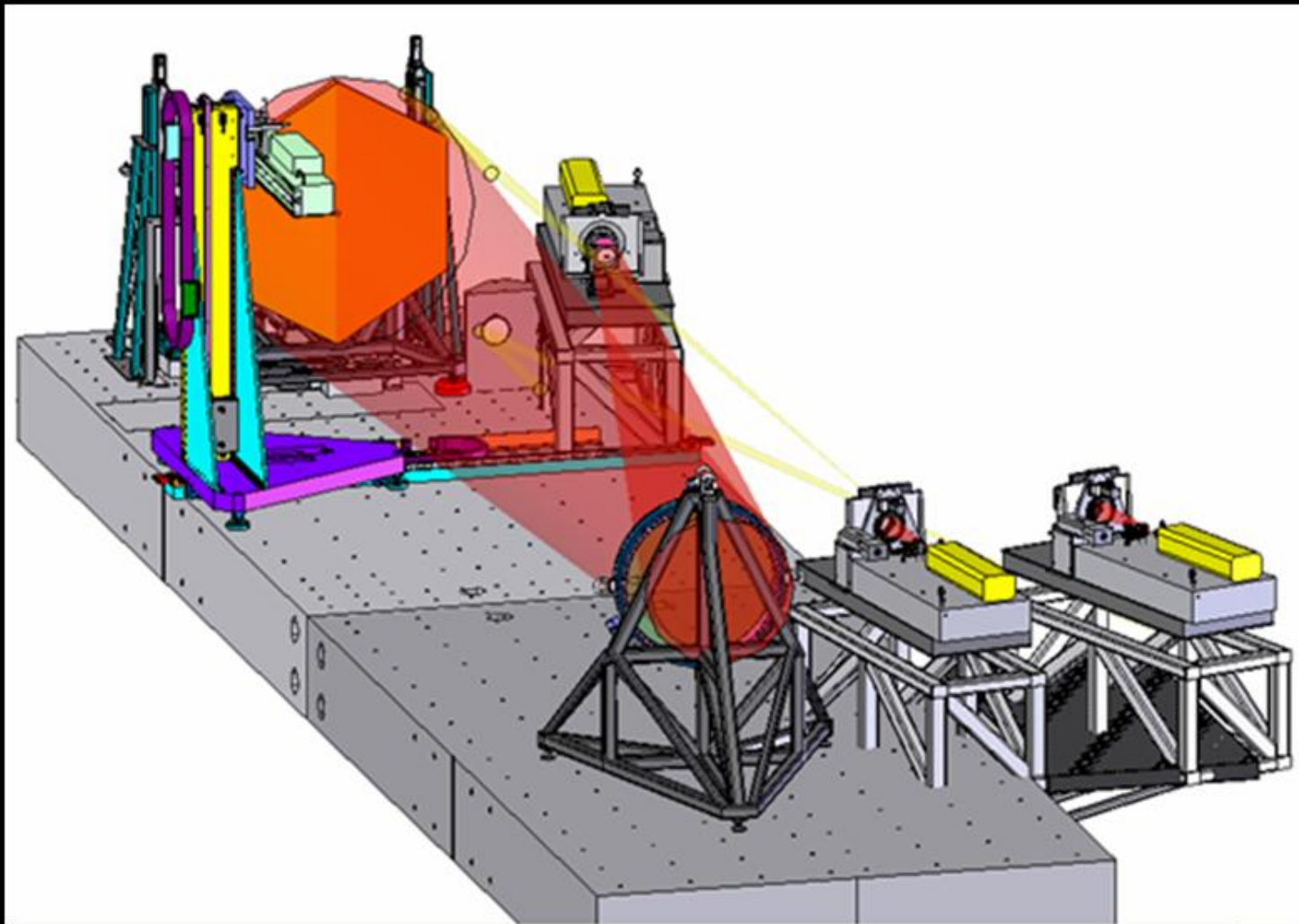


Primary Mirror Test Stand – Tinsley Laboratories





Horizontal Optical Test Station – Tinsley Laboratories

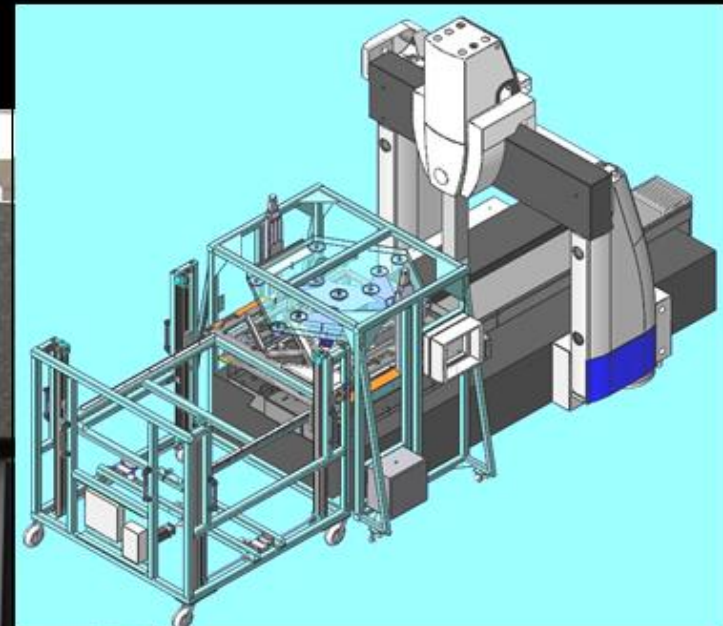
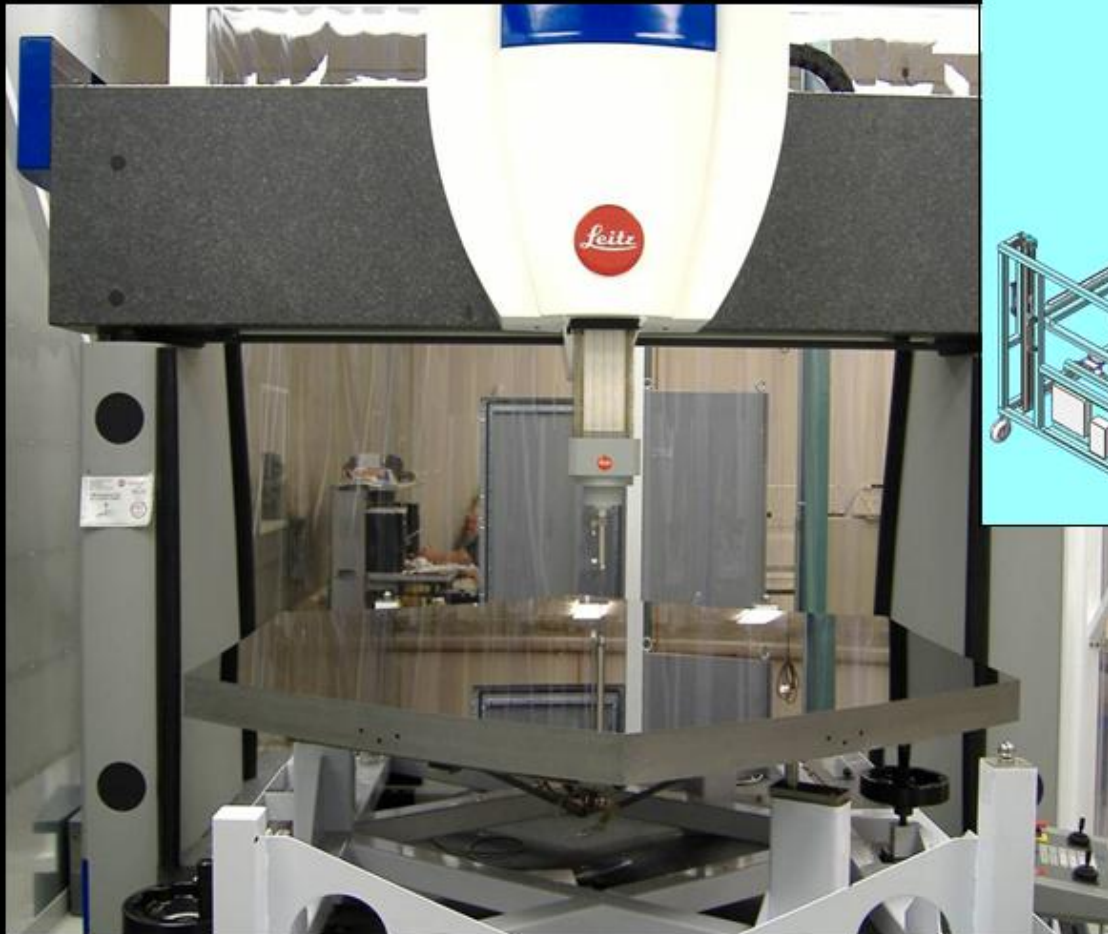




CCM inspection – Tinsley Laboratories



Tinsley CMM measuring AMSD-II Mirror



CMM Station



JWST Mirror Manufacturing Summary



- **Ball Aerospace**
 - PMSA CDA complete
- **Brush Wellman**
 - Blank Manufacturing Completed
- **Axsys Technologies**
 - JWST Facilitization Completed
 - EDU Machining Complete
 - Flight Blank Machining Underway
- **Tinsley Laboratories**
 - JWST Facilitization Nearly Complete
 - Preparations for EDU Processing 95% Complete
- **MSCF – XRCF**
 - Facility Upgrades In-Process